MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2021/2022 (2135)

PPH0046 – MECHANICS

(Foundation in Engineering)

7 OCTOBER 2022
9.00 a.m - 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 3 pages excluding the cover page and the appendices with **FIVE** questions only.
2. Answer **ALL** questions. Distribution of the marks for each question is given.
3. Write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

Question 1: [10 marks]

a) Define the following terms:
   i) Work

   ii) Work-Energy Theorem

(LO1, 3 marks)

b) At a height of 1.0 m, a 10.0-kg block slides from rest on a frictionless incline plane as depicted in **Figure Q1**. The block continues to slide along a 10.0-m rough horizontal raised section of coefficient of kinetic friction 0.20. Will the block fall from the raised section? Support your answer with mathematical calculation.

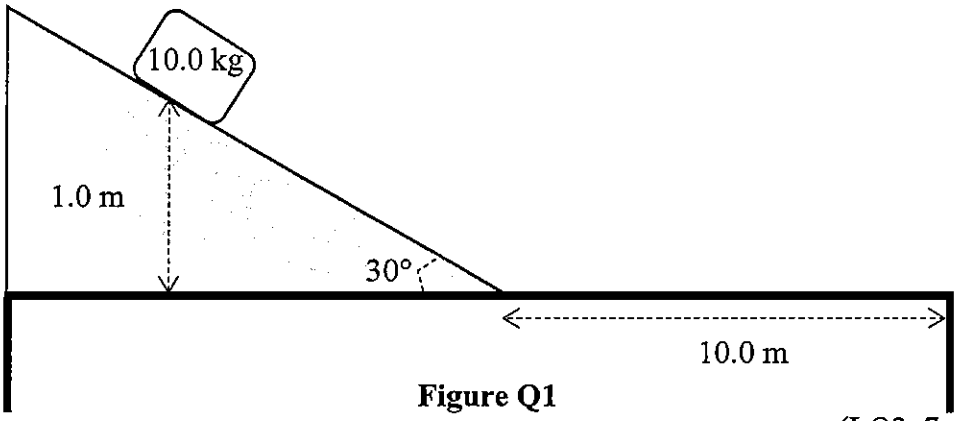

Figure Q1

(LO2, 7 marks)

Question 2: [10 marks]

a) Write the equation for the following quantities and explain each term used in the equation:
   i) Angular acceleration

   ii) Angular momentum

(LO1, 4 marks)

b) Due to emergency reason, the operator of a carousel puts on the brake to bring the carousel to a stop when it is rotating at the rate of 1.0 revolution every 3.0 seconds. The brake produces a constant deceleration of 0.3 radians/s^2.
   i) If your seat on the carousel platform is 2.0 m from the center, what is your speed when the carousel is turning at a constant rate, before the brake is applied?

   ii) How long does it take before the carousel comes to a stop?

   iii) How many revolutions does the carousel make while it is coming to a stop?

(LO2, 6 marks)

Continued...

Question 3: [10 marks]

a)

i) "The *escape speed* of the Earth is 11 km/s." What does the term *escape speed* mean in the statement?

ii) Is *escape speed* the same as *orbital speed*? Provide mathematical reasoning to your answer.

iii) Explain the difference between the *Force of Gravity* as termed in the Newton's Law of Gravitation and the term *Weight* as often used in daily life.

(LO1, 5 marks)

b) A satellite of mass 275 kg is launched from a site on the Equator into an orbit at 150 km above Earth's surface. Assuming that the orbit is circular,

i) what is the satellite's speed in orbit?

ii) What is the orbital period of this satellite?

(LO2, 5 marks)

Question 4: [10 marks]

a)

i) State the definition of *density of mass*.

ii) Write the equation of pressure in liquid in term of depth in liquid.

iii) What is *Archimedes' Principle* ?

(LO1, 4 marks)

b) An equilibrium is reached when a precious metal palladium block is placed on top of a 1.0-kg wood block (density, $\rho_{wood} = 0.60 \times 10^3$ kg/m^3) floating in water (density, $\rho_{water} = 1.00 \times 10^3$ kg/m^3) in such a way that the top surface of the wood block is exactly on the water surface as shown in **Figure Q4**.

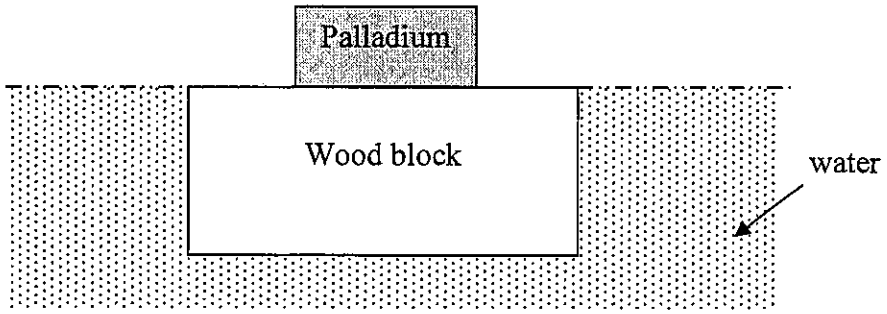

Figure Q4

Continued...

i) Construct a Free Body Diagram (*FBD*) to show all types of forces exerting on the two-block system. Label the forces clearly on the diagram.

ii) Determine the volume of the palladium block, given that the density of palladium, $\rho_{palldium}$, is 12.020×10^3 kg/m^3.

(LO2, 6 marks)

Question 5: [10 marks]

a)

i) With an aid of a diagram, state the terms "Amplitude" and "Period" of an oscillation system.

ii) Total energy of an oscillatory system is said to be dependable on its amplitude. Write the equation for total energy in term of amplitude.

iii) For a mass-spring system undergoing simple harmonic motion, its total energy is stored in the form of potential energy in the spring and kinetic energy of the mass. Describe the relation of the change in potential energy and kinetic energy.

(LO1, 4 marks)

b) For a mass-spring undergoing simple harmonic motion, its equation of motion is given by $x = (5.0) \sin (2.5\pi t - \pi/3)$, where x is in meters and t is in seconds. If the mass is 1.2 kg, determine.

i) the period, frequency and phase constant of the motion,

ii) the displacement at $t = 0.20$ s,

iii) the total energy and

iv) at what times does the mass exprience maximum velocity.

(LO2, 6 marks)

End of Paper

APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2 /C^2
Permittivity of free space	ϵ_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Earth:

Gravity	=	9.81 m s^{-2}
Radius	=	6.38×10^6 m
Mass	=	5.98×10^{24} kg

Moon:

Mass	=	7.35×10^{22} kg
Radius	=	1.74×10^6 m

Sun:

Mass	=	1.99×10^{30} kg
Radius	=	6.96×10^8 m

Mean distance from:

Sun to Earth	=	1.50×10^{11} m
Moon to Earth	=	3.85×10^8 m

APPENDIX II

List of Formulas

$$y = kx^n \qquad \frac{dy}{dx} = knx^{n-1}$$

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} \quad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} \quad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$$

$$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$$

$$v = v_o + gt \qquad y - y_o = v_o t + \frac{1}{2}gt^2 \qquad v^2 = v_o^2 + 2g(y - y_o)$$

$$y - y_o = \left(\frac{v_o+v}{2}\right)t \qquad v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t}$$

$$a_c = \frac{v^2}{r} \qquad F_g = G\frac{m_1 m_2}{r^2} \qquad U_g = -G\frac{m_1 m_2}{r} \qquad T^2 = K_s r^3$$

$$\tau = rxF \qquad \sum\tau = \tau_{net} = I\alpha \qquad I = \sum mr^2 \qquad v = r\omega$$

$$L = rxp = I\omega \qquad K = \frac{1}{2}I\omega^2 \qquad |\tau| = |r||F|\sin\theta$$

$$T_s = 2\pi\sqrt{\frac{m}{k}} \qquad T_p = 2\pi\sqrt{\frac{l}{g}} \qquad T = \frac{2\pi}{\omega} = \frac{1}{f} \qquad \overline{y} = \frac{\sum_{i=1}^{N} m_i y_i}{\sum_{i=1}^{N} m_i}$$

$$x = A\cos\omega t \qquad v = -\omega A\sin\omega t \qquad a = -\omega^2 A\cos\omega t \qquad x = A\sin\omega t$$

$$v = \omega A\cos\omega t \qquad a = -\omega^2 A\sin\omega t \qquad W_F = |r||F|\cos\theta$$

$$v = v_o + at \qquad x - x_o = v_o t + \frac{1}{2}at^2 \qquad v^2 = v_o^2 + 2a(x - x_o)$$

$$x - x_o = \left(\frac{v_o+v}{2}\right)t \qquad W = mg \qquad \sum F = F_{net} = ma \qquad f_s \le \mu_S F_N$$

$$f_k = \mu_K F_N \qquad p = mv \qquad \sum F = \frac{\Delta p}{\Delta t}$$

$$\Sigma W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 \qquad m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v \qquad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\overline{v}$$

$$K = \frac{1}{2}mv^2 \qquad PE_s = \frac{1}{2}kx^2 \qquad F_s = -kx \qquad PE_G = mgy$$

$$\overline{x} = \frac{\sum_{i=1}^{N} m_i x_i}{\sum_{i=1}^{N} m_i} \qquad W_{Fs} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$$